

Description

Sonotrode for an ultrasonic welding device

The invention concerns a tool for an ultrasonic welding device in the form of a sonotrode, which transfers ultrasonic oscillations with at least one working surface for welding metal with ultrasonic oscillations running in the direction of the sonotrode's longitudinal axis, whereby the sonotrode or a sonotrode head exhibits a front surface, which runs perpendicular or essentially perpendicular to at least one working surface.

When assembling materials using ultrasound, the energy needed for welding is in the form of mechanical oscillations into the welding material, whereby the tool, which is also designated a sonotrode, is coupled with the part to be joined, which is immigrated toward it and moves this. At the same time, the parts to be joined are compressed on one another by a static welding strength. Welding of the parts to be joined takes place through the interaction of static and dynamic forces, without which would require additional materials.

Both plastics and metals can be welded by means of ultrasound. The mechanical oscillations are aligned parallel to the joined surface. This results in a complex relationship between the static strength, the oscillating shearing force, and a moderate temperature rise in the welding zone.

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For this, the workpieces are arranged between the vibrating sonotrode and a static backplate electrode, which can be designed in a multipart format, in order to limit the sonotrode, i.e. the working surface of their heads of a compression chamber. This can be designed in two directions running perpendicular to each other, in particular height and width, as in EP-B-0 143 936 or DE-C-35 08 122. Thereby, an alignment to the cross sections results from conductors to be welded, for example.

In order to obtain reproducible welding results of high quality, the deflection of the sonotrode should take place predominantly alone in the longitudinal direction, thus in the direction of the ultrasonic oscillation, without which a deflection takes place perpendicular to this to a noticeable extent.

The known sonotrodes exhibit front surfaces bordering working surfaces. According to construction, a high deflection of the working surface takes place perpendicular to the sonotrode's longitudinal axis in relation to the deflection in the direction of the sonotrode's longitudinal axis. Thereby, the disadvantage results that the working surface can run bent to the sonotrode's longitudinal axis, so that a gap can be formed between the working surface and the available parts, which run parallel to the sonotrode's longitudinal axis.

A sonotrode of the kind initially specified is taken from WO-A-02/43915. In order to replace the working surfaces, these sections are composed of working parts, which are detachable and combinable with the sonotrode.

From FR-A-1 464 551 an ultrasonic welding device is taken, which generates bending oscillations. For this, an element for bending oscillations runs, on whose end a working surface runs, preferably at a right angle to an oscillating element, at which direct ultrasonic oscillations are transferred.

In order to disperse fluid, US-A-4 074 152 proposes the ultrasonic start of oscillation of a hollow cylinder element, which is integrated with an oscillation amplitude amplifier. For this, a projection protrudes from the hollow cylinder element, which interferes with the correspondingly adjusted recess of the amplitude amplifier.

The present invention solves the problem by further developing a sonotrode of the kind initially specified, in which the oscillation form of the ultrasonic oscillation is optimized.

For solving the problem, the invention essentially proposes that, for reducing deflection of at least one working surface perpendicular to the sonotrode's longitudinal axis, the front surface of the sonotrode, sonotrode head, or backside of the sonotrode exhibit at least one reinforcement.

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The reinforcement can, thereby, be trained as a rib. The reinforcement from the edge of the sonotrode and/or its head can be trained rising in the direction of the sonotrode's middle axis. The reinforcement can, for example, exhibit triangle geometry in a section of the sonotrode's longitudinal axis.

It is proposed, in particular, that the reinforcement is trained linear or toric and runs parallel to the working surface. Furthermore, the reinforcement can project, in particular, over the entire or essentially entire front surface of the sonotrode and/or its head. Preferably, the reinforcement is trained symmetrically to a symmetry plane, in which the sonotrode's longitudinal axis runs. Other geometries are also possible.

Preferably, the sonotrode is reinforced in such a way that, with ultrasonic excitation, deflection a_z of the sonotrode, in whose longitudinal axis direction acts perpendicular to the working surface at deflection as $3 \leq a_z / a_y \leq 20$.

According to the theory of the invention, the sonotrode, the sonotrode's head exhibiting the working area, respectively, is reinforced, whereby the vibrating form of the sonotrode is positively affected in such a way that the deflection decreases perpendicular to the sonotrode's longitudinal axis and more strongly outweighs the oscillation in the longitudinal direction.

By reinforcing the head, the gradient of the working surface is clearly reduced and the relationship of deflection in the direction of the longitudinal axis to the deflection is increased perpendicular to the direction of the longitudinal axis.

If the configuration of the reinforcement occurs, preferably via a rib, which becomes thicker in relation to the sonotrode's longitudinal axis, other geometries are also possible. The reinforcement rib can be trained both over the entire width, and over a part of the sonotrode. The contour of the reinforcement rib can be formed, on average, by sharp straight lines or a continuous changing curve, which is cut, in its maximum of the sonotrode's longitudinal axis.

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Tool for an ultrasonic welding device

1. Tool for an ultrasonic welding device in the form of a sonotrode (22), which transfers ultrasonic oscillations with at least one working surface (28, 30) for welding metal with ultrasonic oscillations running in the direction of the sonotrode's longitudinal axis, whereby the sonotrode or sonotrode head (26) exhibits a front surface (32), which runs perpendicular or essentially perpendicular to at least one working surface, thus characterized, that, for reducing deflection of at least one working surface (28, 30) perpendicular to the sonotrode's longitudinal axis (40), the front surface (32) of the sonotrode (22), sonotrode head (26) or backside of the sonotrode exhibit at least one reinforcement (34, 36, 38).
3. Tool according to Claim 1 or Claim 2, characterized in that the reinforcement (34, 36, 38) is a rib.
4. Tool according to least one of the preceding claims, characterized in that the reinforcement (36) exhibits triangle geometry in a section of the sonotrode's longitudinal axis.
5. Tool according to at least one of the preceding claims, characterized in that the reinforcement (36, 38) protrudes from the peripheral edge of the front surface (32), of the working surface (28, 30), respectively, of the sonotrode (22) starting in the direction of the sonotrode's longitudinal axis (40) incrementally over the front surface (32).

6. Tool according to at least one of the preceding claims, characterized in that the reinforcement (36, 38), in particular, runs perpendicular to the working surface (28, 30).
7. Tool according to at least one of the preceding claims, characterized in that the reinforcement (36, 38) is trained in a linear manner.
8. Tool according to at least one of the preceding claims, characterized in that the reinforcement (36, 38) projects from the entire, or essentially entire, front surface (32).
9. Tool according to at least one of the preceding claims, characterized in that the reinforcement (36, 38) is trained symmetrically to a symmetry plane, in which the sonotrode's longitudinal axis (40) runs.
10. Tool according to at least one of the preceding claims, characterized in that the reinforcement (38) is trained in a beaded manner, as a beam in a linear manner, respectively.
11. Tool according to at least one of the preceding claims, characterized in that the sonotrode (22) is reinforced in such a way that, with ultrasonic excitation, deflection a_z of the sonotrode, acts in the direction of its longitudinal axis (40) by deflecting a_y perpendicular to the working surface (28, 30), as $3 \leq a_z / a_y \leq 20$.
12. Tool according to at least one of the preceding claims, characterized in that the maximal extension d of the reinforcement (36, 38), over the front surface (32) is $3 \text{ mm} \leq d \leq 25 \text{ mm}$, preferably $5 \text{ mm} \leq d \leq 15 \text{ mm}$.

13. Tool according to at least one of the preceding claims, characterized in that the extension of the reinforcement (36, 38), over the front surface (32), is maximally 10 mm.